Appendix B

Development and Use of Risk-Based Concentrations to Select an Area for Remedial Action

This appendix describes the development and use of site-specific Risk-Based Concentrations (RBCs) to identify the area where remedial action is appropriate for soil at the Rolling Knolls Landfill Superfund Site located in the Township of Chatham, Morris County, New Jersey (the "Site"). To support this evaluation, an iterative approach was used to compare exposure point concentrations (EPCs) of polychlorinated biphenyls (PCBs), the primary risk driver and only constituent with an individual constituent hazard index above one (1), outside the proposed area to be remediated to the Site-specific RBCs.

BACKGROUND INFORMATION

Site Features

The Site is a former municipal landfill in use from the 1930s to 1968. It consists of approximately 140 acres of landfill, with an adjacent 30-acre area west of the landfill that has debris scattered on the surface, but no buried waste (known as the Surface Debris Area). The Site features are shown on Figure B-1. Most of the landfill and the Surface Debris Area are privately owned. Approximately 35 acres of the landfill are on the Great Swamp National Wildlife Refuge (GSNWR).

Current Uses

Currently, a Baseball Field and a Shooting Range are located north of the landfill and are used occasionally for recreation. A small building known as the Hunt Club is located in the Surface Debris Area near the western boundary of the landfill; it is generally unoccupied but is used occasionally for social gatherings. Two areas of the Site (Landscaper Areas 1 and 2) are leased to landscaping firms for the storage of trucks and equipment. An area of the Site north of the landfill is used by Chatham Disposal and South Orange Disposal for the storage of roll offs.

Previous Risk Assessments

The Baseline Human Health Risk Assessment (BHHRA) prepared by CDM Federal Programs Corporation (CDM Smith) in June 2014 calculated individual constituent and cumulative reasonable maximum exposure (RME) and central tendency exposure (CTE) cancer and non-cancer risks for current and reasonably anticipated future exposure scenarios and receptors, including adolescent and adult trespassers. The individual constituent RME cancer risks were less than United States Environmental Protection Agency (USEPA) target values for the receptors evaluated. The individual constituent RME non-cancer risks were greater than the USEPA target value (hazard index, HI) of 1 for adolescent and adult trespassers only. The non-cancer health hazard drivers are primarily PCBs for these receptors.

The results of the Baseline Ecological Risk Assessment (BERA) prepared by Integral Consulting, Inc. dated December 30, 2016, indicated that exposures to constituents of potential ecological concern in the environmental media at the Site do not pose an ecological concern for most of the evaluated receptors and that there is a low potential risk for vermivorous birds and mammals. This evaluation has focused on human health risk to assess the area where remediation is appropriate on the landfill portion of the Site.

Anticipated Future Use

The operations currently ongoing within the landfill (the Hunt Club and two landscaper areas) are assumed to not continue beyond the completion of the soil remedial action at the Site. No future residential, industrial, commercial, recreational, or other use of the Site is anticipated.

DEVELOPMENT OF SITE-SPECIFIC RISK BASED CONCENTRATIONS

The adolescent trespasser receptor was used as the basis to develop the RBCs because it was the receptor with the highest potential health hazard. RBCs were calculated for PCBs, specifically non-dioxin-like PCBs, PCB toxic equivalent (TEQ), and dioxin TEQ; total xylenes; and antimony which account for approximately 90% of the cumulative health hazard.

Receptor: Adolescent Trespasser (Landfill)

	Exposure Point Concentration (mg/kg)	Soil Combined Dermal, Ingestion, and Inhalation HI	Percent of Cumulative HI	Site-Specific RBC (mg/kg)
Non-dioxin-like PCBs	57.42	3.3	57%	10
PCB TEQ	0.00042	0.7	12%	0.00007
Dioxin TEQ	0.00049	0.62	11%	0.00008
Total Xylenes	7,288	0.3	5%	1,300
Antimony	119	0.24	4%	21
	Cumulative HI:	5.8		

Notes:

1. Site-specific RBCs were calculated according to the following equation:

$$RBC = EPC \times \frac{Target\ HI\ (1)}{Cumulative\ HI\ (5.8)}$$

2. mg/kg = milligrams per kilogram

3. Site-specific RBCs are rounded to two significant figures or one significant figure if the value is 10 or less.

EXPOSURE POINT CONCENTRATIONS

To support the evaluation of the area to be remediated, an iterative approach was used to compare exposure point concentrations (EPCs) of PCBs, the primary risk driver and only constituent with an individual constituent hazard index above one (1), outside the proposed area to be remediated to the RBCs. Because the data sets for the PCB congener (non-dioxin-like PCBs and PCB TEQ) and dioxin (dioxin TEQ) were too small to support the evaluation of the impact of a cap on the EPC in readily accessible soil, Aroclor data (for which there was greater data density) was used. Total PCBs as the sum of Aroclors was the only constituent evaluated to support the determination of the area where remediation was appropriate.

This approach included removing the highest PCB concentrations from the data set (listed in Table B-1), in a step-wise manner and taking into consideration the spatial relationship

of the data, calculating the 95 percent upper confidence limit of the mean (95UCL) as the EPC for PCBs, comparing the EPC to the RBC, and continuing the process until the EPC was below the RBC. This approach results in a more spatially contiguous and manageable remediation area, rather than the many small, piecemeal remediation areas which would have resulted if the approach had focused solely on the highest PCB concentration.

USEPA's ProUCL version 5.1.002 was used to calculate the 95UCL as the EPC for PCBs (as the sum of Aroclors) for the shallow soils (0-2-foot depth interval) outside the area to be remediated as this would be accessible to an adolescent trespasser. The EPC for PCBs remaining outside the area to be remediated was calculated as 3.6 mg/kg, below the PCB RBC of 10 mg/kg as well as below the calculated PCB Alternative Remediation Standard (ARS) of 5 mg/kg. The ProUCL output is included as Attachment B-1 to this appendix.

CONCLUSIONS

Based on the iterative approach described previously, the area selected for remediation (Selected Area) is approximately 25 acres and is shown on Figure B-1. The extent of the Selected Area encompasses the soil samples listed in Table B-1; those soil samples which are on the boundary of the Selected Area (POI-10, SS-55, SS-64, SS-67, and SS-73), as shown on Figure B-2, will be remediated along with the samples located in the interior of the Selected Area. The extent of the Selected Area may be modified based on pre-design investigation sampling conducted prior to the remedial design.

While this risk-based approach leaves PCBs above the RBC and the ARS outside of the Selected Area, the EPC for PCBs in shallow soil outside the Selected Area is 3.6 mg/kg, below the RBC of 10 mg/kg and below the ARS of 5 mg/kg. Therefore, remediating the Selected Area alone is protective of human health of potential receptors in the landfill portion of the Site. However, to supplement the Selected Area and further reduce risk, those sample locations which contain PCB concentrations greater than three times the ARS of 5 mg/kg are designated Areas of Particular Concern (APCs; discussed in Section 5 of the Feasibility Study Report) and will be further remediated. Certain other soil samples contain other constituents at concentrations more than three times their ARS, are also considered APCs, and will also be remediated. The locations of the APCs are included on Figure B-2.

This memo and its findings will be incorporated into the Feasibility Study Report for the Rolling Knolls Site.

REFERENCES

CDM Federal Programs Corporation, 2014. *Baseline Human Health Risk Assessment, Rolling Knolls Landfill Superfund Site, Chatham, New Jersey*. June.

Integral Consulting. 2016. *Baseline Ecological Risk Assessment,* Rolling Knolls Landfill Superfund Site. September.

TRC, 2017. *Reuse Assessment Report, Rolling Knolls Landfill Superfund Site, Chatham, New Jersey*. February.

USEPA, 2016. *ProUCL version 5.5.002*. June 20. https://www.epa.gov/land-research/proucl-software.

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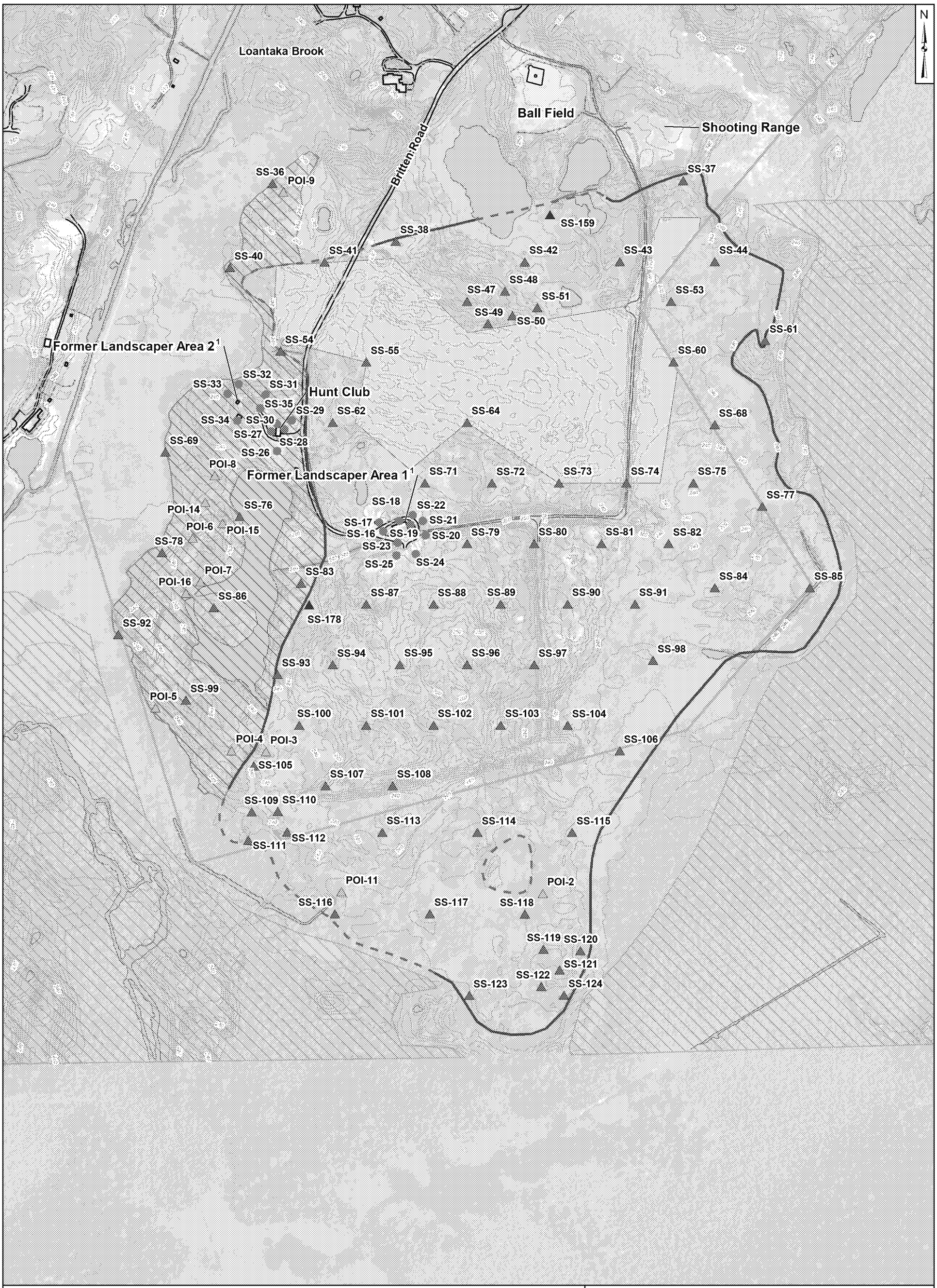

Note 1: These features to be removed from landfill area prior to completion of soil remedy.
Site Plan created from Arcadis CAD drawings received December 2015.
Aerial imagery accessed via ArcGIS Online and provided by the United States Department of Agriculture on 27 December 2017. Image is dated 31 July 2015.

400 200 0 400 Feet

Legend

Locations of Soil Samples Used to Calculate Exposure Point Concentration

- Soil Sample Location Near Areas of Current Human Use (First Phase of RI)
- Soil Sample Location At Point of Interest (First Phase of RI)
- Other Soil Sample Location (First Phase of RI)
- Soil Sample Location (Second Phase of RI)

- Selected Area for Risk-Based Remediation
- Edge of landfilled wastes (dashed where approximate)
- Great Swamp National Wildlife Refuge property boundary
- Areas where surface water flow does not exhibit typical bed and bank morphology
- Waste and debris observed on ground surface but not observed or anticipated below ground surface
- Open water

Selected Area to be Remediated

ROLLING KNOLLS LANDFILL SUPERFUND SITE
CHATHAM, NEW JERSEY

Geosyntec consultants

Princeton, NJ | December 2017

Figure **B-1**

P:\GIS\Rolling Knolls\Report 1\FS Figure B-1 Area to be Remediated V2.mxd

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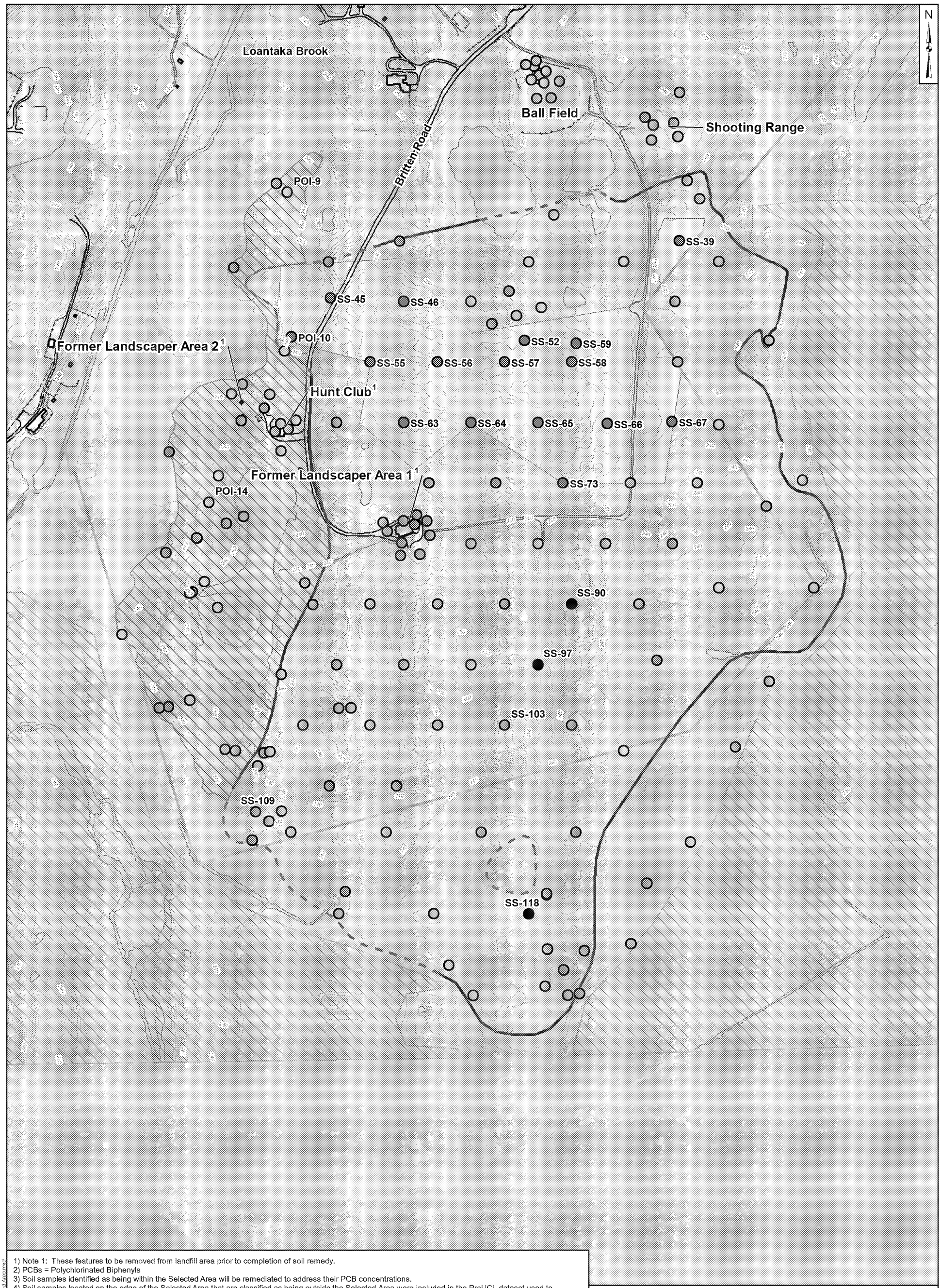

1) Note 1: These features to be removed from landfill area prior to completion of soil remedy.
2) PCBs = Polychlorinated Biphenyls
3) Soil samples identified as being within the Selected Area will be remediated to address their PCB concentrations.
4) Soil samples located on the edge of the Selected Area that are classified as being outside the Selected Area were included in the ProUCL dataset used to calculate the Exposure Point Concentration (EPC) for PCBs. While remediation of these samples is not required to meet the EPC, these samples will be included in the remediation as a conservative measure.
5) Site Plan created from Arcadis CAD drawings received December 2015.

400 200 0 400 Feet

Legend

- Soil Samples Outside Selected Area
- Soil Samples Inside Selected Area
- Areas of Particular Concern - PCBs
- Areas of Particular Concern - Other Constituents
- Selected Area for Risk-Based Remediation
- Edge of landfilled wastes (dashed where approximate)
- Great Swamp National Wildlife Refuge property boundary
- Areas where surface water flow does not exhibit typical bed and bank morphology
- Waste and debris observed on ground surface but not observed or anticipated below ground surface
- Open water

Soil Samples Addressed with the Selected Area

ROLLING KNOLLS LANDFILL SUPERFUND SITE
CHATHAM, NEW JERSEY

Geosyntec consultants

Princeton, NJ | May 2018

Figure **B-2**

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Table B-1
Soil Sample Locations Requiring Remediation Based on Statistical Risk Evaluation

Rolling Knolls Landfill Superfund Site - Feasibility Study
Chatham, New Jersey

Sample Location Name
POI-10
SS-39
SS-45
SS-46
SS-52
SS-55
SS-56
SS-57
SS-58
SS-59
SS-63
SS-64
SS-65
SS-66
SS-67
SS-73

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.111/9/2017 5:42:18 PM
From File	aroclors - outside cap.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Aroclors

General Statistics

Total Number of Observations	110	Number of Distinct Observations	77
Number of Detects	81	Number of Non-Detects	29
Number of Distinct Detects	73	Number of Distinct Non-Detects	7
Minimum Detect	0.01	Minimum Non-Detect	0.03
Maximum Detect	29	Maximum Non-Detect	0.89
Variance Detects	22.68	Percent Non-Detects	26.36%
Mean Detects	3.67	SD Detects	4.762
Median Detects	2.29	CV Detects	1.297
Skewness Detects	3.024	Kurtosis Detects	12.2
Mean of Logged Detects	0.291	SD of Logged Detects	1.841

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.706	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.221	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0985	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	2.708	KM Standard Error of Mean	0.419
KM SD	4.368	95% KM (BCA) UCL	3.439
95% KM (t) UCL	3.403	95% KM (Percentile Bootstrap) UCL	3.422
95% KM (z) UCL	3.397	95% KM Bootstrap t UCL	3.585
90% KM Chebyshev UCL	3.965	95% KM Chebyshev UCL	4.535
97.5% KM Chebyshev UCL	5.325	99% KM Chebyshev UCL	6.878

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.626	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.807	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0763	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.104	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.611	k star (bias corrected MLE)	0.596
Theta hat (MLE)	6.009	Theta star (bias corrected MLE)	6.154
nu hat (MLE)	98.94	nu star (bias corrected)	96.61
Mean (detects)	3.67		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	2.705
Maximum	29	Median	0.82
SD	4.389	CV	1.623
k hat (MLE)	0.339	k star (bias corrected MLE)	0.336
Theta hat (MLE)	7.983	Theta star (bias corrected MLE)	8.059
nu hat (MLE)	74.55	nu star (bias corrected)	73.85
Adjusted Level of Significance (β)	0.0478		
Approximate Chi Square Value (73.85, α)	55.06	Adjusted Chi Square Value (73.85, β)	54.85
95% Gamma Approximate UCL (use when n>=50)	3.628	95% Gamma Adjusted UCL (use when n<50)	3.643

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	2.708	SD (KM)	4.368
Variance (KM)	19.08	SE of Mean (KM)	0.419
k hat (KM)	0.384	k star (KM)	0.38
nu hat (KM)	84.58	nu star (KM)	83.61
theta hat (KM)	7.044	theta star (KM)	7.126
80% gamma percentile (KM)	4.343	90% gamma percentile (KM)	7.717
95% gamma percentile (KM)	11.45	99% gamma percentile (KM)	20.9

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (83.61, α)	63.53	Adjusted Chi Square Value (83.61, β)	63.3
95% Gamma Approximate KM-UCL (use when n>=50)	3.564	95% Gamma Adjusted KM-UCL (use when n<50)	3.577

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.903	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	1.0262E-6	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.16	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0985	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	2.716	Mean in Log Scale	-0.648
SD in Original Scale	4.383	SD in Log Scale	2.276

95% t UCL (assumes normality of ROS data)	3.409	95% Percentile Bootstrap UCL	3.426
95% BCA Bootstrap UCL	3.559	95% Bootstrap t UCL	3.639
95% H-UCL (Log ROS)	15.46		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-0.877	KM Geo Mean	0.416
KM SD (logged)	2.519	95% Critical H Value (KM-Log)	3.972
KM Standard Error of Mean (logged)	0.25	95% H-UCL (KM -Log)	25.94
KM SD (logged)	2.519	95% Critical H Value (KM-Log)	3.972
KM Standard Error of Mean (logged)	0.25		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	2.712	Mean in Log Scale	-0.8
SD in Original Scale	4.386	SD in Log Scale	2.44
95% t UCL (Assumes normality)	3.405	95% H-Stat UCL	21.8

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM Approximate Gamma UCL	3.564

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.